

of those directly facing the gale. I naturally expected to have it strong in my face; but, on the contrary, I found I had almost as perfect a shelter from the wind as if I had been on the other side.

C. M. INGLEBY

Malvern Wells, July 3

AFFINITIES OF THE SPONGES

MR. H. J. CARTER is devoting much attention at the present moment to the study of the Protozoa. In March last he published in the *Annals and Magazine of Natural History* the results of his investigations on Cocoliths and Cocospheres, stating his opinion that these minute bodies are of vegetable and not animal organisation, as hitherto supposed. Should his supposition prove correct, it will materially modify the theory of the mode of support of animal life at great depths, advocated by many recent deep-sea explorers. In the pages of the same journal for this month (July), Mr. Carter lays before us the results of his more recent researches into the ultimate structure of the marine calcareous sponges, and which entirely harmonise with those already arrived at by Prof. James Clark, of Boston, U.S. The sum total of these are that the Spongiadæ, as a group, are most closely allied to the Flagellate Infusoria; the animal portions of the genera *Leuconia*, *Grantia*, and *Clathrina* among the calcareous sponge-forms, and *Spongilla*, *Isodictya*, *Hymeniacidon*, and *Cliona* among the silicious representatives examined by Mr. Carter, being found by him to consist, for the most part, of aggregations of the same peculiar funnel-bearing ciliated cells characteristic of the new Flagellate Infusorial genera *Codosiga*, *Salpingoeca*, *Bicosoeca*, &c., introduced by Prof. Clark. The only point at issue between these two explorers in the same field is, whether each separate cell possesses a distinct mouth, or is capable of engulfing food, after the manner of an ordinary Rhizopod, through any portion of its body. Mr. Carter here adopts the latter view.

The most important result of Mr. Carter's investigations is, however, the additional evidence he brings forward in refutation of Ernst Haeckel's no longer tenable hypothesis, that the sponges are most closely allied to, and should even be collated in the same primary group as, the Cœlenterata. Prof. Haeckel's opinions have already been strongly opposed by myself (See *Ann. and Mag. Nat. Hist.* for March and September 1870); and Mr. Carter's recent investigations practically deprive Prof. Haeckel and those supporting his views of their last foot-hold. The Calcispongiæ is the group on which Ernst Haeckel and his collaborateur Mickluco-Maclay have more particularly concentrated their attention; it is the especial one, again, they have made choice of, as demonstrating in their opinion, more closely than any, the relationship they would seek to establish. Prof. Clark and Mr. Carter, however, prove beyond doubt their bond of union with the Flagellate Infusoria, the addition of a general investing sarcode layer and a spicular or horny supporting skeleton being, indeed, the only clearly defined characters that separates them from the group.

In seeking to establish other affinities, Mr. Carter is scarcely so happy. In his opinion, the Spongiadæ are more closely allied to the compound Tunicata than to the Cœlenterata, but he allows himself to be led further away here by analogous or general external resemblances than even Prof. Haeckel. To effect his purpose, he proposes that the branchial openings in the gelatinous mass of *Botryllus* "are analogous if not homologous" with the pores of the Spongiadæ, while the common cloacal cavity and faecal orifice are respectively analogous to the excretory canal system and vent. Fascinating as these external resemblances may appear at first sight, we must penetrate a little beneath them, and before Mr. Carter can hope to substantiate the affinities he would establish, he must demonstrate to what extent the individual zooids of the As-

cidian colony can be correlated with the single or aggregated ciliated cells of the sponges. In the former we have highly-organised animals, possessing a well-developed neural, hæmal, digestive, and respiratory system, while in the latter, simple unciliated cells and undifferentiated sarcode are the only materials to be dealt with. Mr. Carter, again, would institute comparisons between the tough, gelatinous, or albuminous mass in which the Ascidian zooids are embedded, and that sarcode layer more or less generally diffused throughout all sponge structures; but in the first we have formed matter, like bone, horn, or shell, no longer possessing vital properties, while in the sarcode of the sponge we have living substance constantly altering its conditions of relationship, secreting the supporting skeleton, and contributing to the general welfare of the sponge community. Mr. Carter's inference in support of his proposition, drawn from the presence of calcareous bodies resembling spiculæ being met with in certain compound Ascidia, is but of little importance, considering that comparisons on the same grounds might be made between the sponges and the Nudibranchiate Mollusca; these latter likewise frequently secreting calcareous spiculæ in the substance of their integument.

The hiatus between the Spongiadæ and the Tunicata is far too wide to admit of such an institution of homological comparisons; the group of the Cœlenterata is evidently the nearest related to the former, but even here there are at present too many important links wanting to justify our uniting the two in one sub-kingdom, as proposed by Haeckel. *Inter se*, the sponges constitute a very natural division of the Protozoa, intimately related on the one hand through their special ciliated cells to the Flagellate Infusoria, and by the remaining sarcode layer, or skeletal secreting portion, to the simpler Rhizopoda.

In the paper here alluded to, Mr. Carter describes, under the name of *Trychogypsia*, a new calcareous sponge form differing from all others with which he is acquainted in possessing linear fusiform and no triradiate or quadri-radiate spicules. The genus *Aphroceras*, described by Dr. Gray in 1858 (see *Proc. Zoo. Soc.*, pp. 113, 114), is recognised by the same characters.

W. SAVILLE KENT

ON RECENT MOA REMAINS IN NEW ZEALAND

IN January 1864 a remarkably perfect specimen of *Dinornis robustus*, Owen, found on the Manuharekia Plains in the interior of the Province of Otago, was transmitted to the museum at York, and formed the subject of a memoir by Prof. Owen in the Transactions of the Zoological Society for 1869. These remains were considered unique on account of the well-preserved condition of some parts of the skeleton, portions of the ligaments, skin, and feathers being still attached to some of the bones, whereas Moa bones in the condition in which they are usually found are partially fossilised, or have at least undergone a sufficient change to deprive them not only of all ligamentous appendages, but to some extent of their proper proportion of organic matter. The discovery in the following year of the unique specimen (now in the museum) of a Moa's egg containing the bones of an embryo chick and attached membranes—within twenty miles of the same locality—was recorded by me in 1867 (*Proc. Zool. Soc.* p. 991.) I have now to announce the acquisition of another interesting specimen from the same district, being the cervical vertebrae of a Moa, apparently of the largest size, upon the posterior aspect of which the skin, partly covered with feathers, is still attached by the shrivelled muscles and ligaments.

I saw the specimen in question in the possession of Dr. Thomson, of Clyde, who obtained it from a gold miner. It was discovered in a cave formed by an over-

hanging mass of mica schist, but the particulars of the locality have not yet been accurately ascertained, or whether any other parts of the bird are still to be found. Dr. Thomson has kindly undertaken to prosecute a further search, and to forward the specimen already obtained to the museum for examination.

These interesting discoveries render it probable that the inland district of Otago, at a time when its grassy plains and rolling hills were covered with a dense scrubby vegetation or a light forest growth, was where the giant wingless birds of New Zealand lingered to latest times. It is impossible to convey an idea of the profusion of bones which, only a few years ago, were found in this district, scattered on the surface on the ground or buried in the alluvial soil in the neighbourhood of streams and rivers. At the present time this area of country is particularly arid as composed with the prevalent character of New Zealand. It is perfectly treeless; nothing but the smallest-sized shrubs being found within a distance of sixty or seventy miles. The surface features comprise round-backed ranges of hills of schistose rock with swamps on the top, deeply cut by ravines that open out on basin-shaped plains formed of alluvial deposits that have been everywhere moulded into beautifully regular terraces to an altitude of 1,700 feet above the sea level. That the mountain-slopes were at one time covered with forest, the stumps and prostrate trunks of large pine trees, and the mounds and pits on the surface of the ground which mark old forest land, abundantly testify, although it is probable that the intervening plains have never supported more than a dense thicket of shrubs or were partly occupied by swamps. The greatest number of moa bones were found where rivers debouch on the plains, and that at a comparatively late period these plains were the hunting grounds of the Aborigines can be proved most incontestably. Under some overhanging rocks in the neighbourhood of the Clutha river, at a place named by the first explorers Moa Flat, from the abundance of bones which lay strewn on the surface, rude stone flakes of a kind of stone not occurring in that district were found associated with heaps of Moa bones. Forty miles further in the interior, and at the same place where the Moa's neck was recently obtained, Captain Fraser discovered in 1864 what he described to me as a manufactory for such flakes and knives of chert as could be used as rough cutting instruments in a cave formed by overhanging rocks, sheltered only from S.W. storms, as if an accumulation by a storm-stayed party of natives. With these were also associated Moa bones and other remains. Again, on the top of the Carrick Mountains, which are in the same district, but at an altitude of 5,000 feet above the sea, the same gentleman discovered a gully, in which were enormous heaps of bones, and along with them native implements of stone, among which was a well-finished cleaver of blue slate, and also a coarsely-made horn-stone cleaver, the latter of a material that must have been brought from a very great distance.

Still clearer evidence that in very recent times the natives travelled through the interior, probably following the Moas as a means of subsistence, like natives in other countries where large game abounds, was obtained in 1865-6 by Messrs. J. and W. Murison. At the Maniototo Plains, bones of several species of *Dinornis*, *Aptornis*, *Apteryx*, large Rails, Stringops, and other birds, are exceedingly abundant in the alluvium of a particular stream, so much so that they are turned up by the plough with facility. Attention was arrested by the occurrence on the high-ground terrace which bounds the valley of this stream, of circular heaps composed of flakes and chips of chert, of a description that occurs only in large blocks along the base of the mountains at about a mile distant. This chert is a very peculiar rock, being a "cement" or "water quartz," or sand and gravel converted into a hard quartzite by infiltration of silicious matter. The resem-

blance of the flakes to those they had seen described as found in the ancient Kitchen-Middens, and a desire to account for the great profusion of Moa bones on a lower terrace-shelf nearer the margin of the stream, led the Messrs. Murison to explore the ground carefully, and by excavating in likely spots, they found a series of circular pits partly lined with stones, and containing, intermixed with charcoal, abundance of Moa bones and egg-shells, together with bones of the dog, the egg-shells being in such quantities that they consider that hundreds of eggs must have been cooked in each hole. Along with these were stone implements of various kinds, and of several other varieties of rock besides the chert which lies on the surface. The form and contents of these cooking-ovens correspond exactly with those described by Mantell in 1847 as occurring on the sea-coast, and among the stone implements which Mantell found in them, he remembers some to have been of the same chert, which occurs *in situ* at this locality fifty miles in the interior. The greater part of these chert specimens found on the coast are with the rest of the collection in the British Museum. There are other circumstances which incidentally support the view that while the Moas still existed in great numbers, the country was open and regularly traversed by the natives engaged in hunting. Near the old Maori ovens on the coast Mantell discovered a very curious dish made of steatite, a mineral occurring in New Zealand only on the west coast, rudely carved on the back in Maori fashion, measuring twelve by eight inches, and very shallow. The natives at the time recognised this dish by tradition, and said there should be two of them. It is very remarkable that since then the fellow dish has been discovered by some gold diggers in the Manuherikia Plain, and was in use on a hotel counter at the Dunstan township as a match-box, till lately, when it was sent to England, and, as I am informed, placed in a public museum in Liverpool.

The manner in which the Maoris use their cooking ovens suggests to me an explanation of the mode in which these flakes of chert came to be found in such profusion, while only a few of them show any signs of having been trimmed in order to fit them for implements. The native method of cooking is to heat the hardest stones they can find in the fire, and then placing the food to be cooked on top, to cover the whole with leaves and earth, and through an opening pour in water, which coming in contact with the hot stones, causes the formation of steam by which the food is cooked. If masses of the white chert be heated and quenched with water in the manner described, the result is the formation of flakes of every variety of shape with sharp cutting edges. It is natural to suppose that when one of these flakes was found of shape convenient for a particular purpose, such as a knife, cleaver, or spear-head, it was trimmed and dressed in the manner of a gun-flint, when the edge became defective, rather than thrown away, and favourite forms might be preserved and carried even as far as the coast. This suggested explanation of how a race advanced probably far beyond the period of such rude-looking implements might yet find it convenient to manufacture and use these, is supported by the circumstances that along with the trimmed chert flakes the Messrs. Murison found finished adzes of aphanite and even jade, which shows that the hunting natives had the same implements as those which are so common among the natives at the present day, though their use is now superseded by iron.

In the ovens on the coast, besides flakes and rough knives of chert and flint, are found flake-knives of obsidian, a rock which only occurs in the volcanic district of the North Island, and also adzes and stone axes of every degree of finish and variety of material. Although there is no positive evidence in the latter case that more highly finished implements were in use by a people contemporaneous with the Moa, whose remains, collected by

human agency, are so abundant in the same place, nevertheless the fact of a similar association occurring far in the interior affords strong presumptive evidence on this point, as the finely-finished implements must have been carried inland and to the same spots where the Moa remains occur, to be used at native feasts, of which these bones are the only other existing evidences.

So far I have been dealing with evidence gathered in the South Island of New Zealand of the recent co-existence of Man and the Moa, but in the North Island there is no lack of similar proofs. During the summer of 1866, H.E. Sir George Grey, K.C.B., made a fine collection at Waingongoro on the west coast of this island, being the same locality from which Mantell gathered the magnificent series of bones which he forwarded to Europe in 1847. At this place, along with the bones of the Moa and other extinct birds, were found those of dogs, seals, and many species of birds that are common at the present day, such as the albatross, penguin, nestor, and porphyris, and notably the notornis, a gigantic rail, which till a comparatively recent date, was supposed, like the Moa, to be extinct, and of which as yet only two living examples have been obtained. Associated with these remains Sir George Grey obtained artificially formed stone flakes of a very peculiar kind, being chips from rolled boulders of hard crystalline sandstone, produced by a single blow, probably when the stone was heated and quenched in water. The stones from which these chips were obtained had evidently been used, in the first instance, for cooking, as the ancient *Umus*, or cooking-ovens, are chiefly formed of them; and, indeed, in the sandy tracts on the west coast, where stones are rare, the identical stones that in former days were used for cooking Moas are still in use by the natives of the district for cooking pigs and shell-fish. Here again we find that the same necessity and circumstance which suggested the use of the chert flakes in the South, gave origin to a similar adaptation of the chips from the sandstone boulders. It is of some interest to find that native tradition points to the sandy flat at Waingongoro, called Te Rangatapu, as the spot where the first Maori immigrants to the district originally settled; and there appears to be nothing in the abundant traces which they have left of these great feasts, which we must refer to that period, that would indicate any difference in their domestic habits from those of the Maoris now existing, and who, no doubt, are their direct descendants.

What has been advanced affords strong presumptive evidence that the Moas, although belonging probably to a race that was expiring from natural causes, was finally exterminated through human agency; and on this subject Mr. Murison has suggested how infallibly the wholesale consumption of the eggs, which were evidently highly prized as an article of food, must have led to their rapid extinction, without its being necessary that the birds themselves should have been actually destroyed. That wide-spreading fires contributed, in some instances, to the destruction of these wingless birds, is rendered probable from the occurrence of little heaps of bones, in spots where flocks of them would be overtaken when fleeing before the destroying element. At the south-west extremity of a triangular plain, by the side of the Wakatipu Lake, in 1862, I counted thirty-seven of such distinct skeleton-heaps, where the steep rocky slope of the mountain, covered with fallen blocks and tangled shrubs, meets the lake, and would, therefore, stop the progress of the fugitives in that direction. From what we know of habits of birds akin to the Moas, we may fairly infer that they did not frequent heavily-timbered country, but roamed over coppice-covered plains and mountain slopes. This view is supported by the comparative rarity of Moa remains in forests, the few exceptions being easily accounted for.

The whole of the eastern district of the South Island of New Zealand back to the Southern Alps was completely

surveyed and mapped as early as 1862, and had been thoroughly explored at least ten years before that date, without any of these gigantic birds being met with; but there is a large area of rugged mountainous country, especially in the south-west district of Otago, which even to the present time is only imperfectly known. The mountain sides in this region are clothed with open forest, in which Kiwis, Kakapos, and other expiring forms of apterous birds are still to be found in comparative abundance, but where we could scarcely expect to meet with the larger species. Nevertheless, owing to the lofty tabular configuration of this district, the mountains afford very extensive areas above the forest limit—which are covered with Alpine shrubs and grasses—where it is not impossible that a remnant of this giant race may have remained to very recent times. The exploration, however, to which the country has been subjected during the last few years, by parties of diggers prospecting for gold, forbids any reasonable hope that any still exist. I may here mention that on one of the flat-topped mountains near Jackson's Bay, visited in January 1863, I observed, at an altitude of 4,000 feet, numerous well-beaten tracks about sixteen inches wide intersecting the dense scrub in all directions, and which, owing to the height of the scrub (two to four feet) could only been formed in the first instance by the frequent passage of a much larger bird than either the Kiwi or Kakapo, which, judging from the droppings, were the only birds that now resorted to them. On the sides of the tracks, especially near the upper confines of the forest, are shallow excavations, 2ft. to 3ft. in diameter, that have much the appearance of having been scraped for nests. No pigs or any other introduced animals having penetrated to this part of the country, it appears manifest that these were the tracks of some large indigenous animal, but from the nature of the vegetation it is probable that such tracks may have been for a very long period in disuse, except by the smaller ground birds, without becoming obliterated.

The above facts and arguments in support of the view that the Moa survived to very recent times, are similar to those advanced at an early period after the settlement of the colony, by Walter Mantell, who had the advantage of direct information on the subject from a generation of natives that has now passed away. As the first explorer of the artificial Moa beds, his opinion is entitled to great weight. Similar conclusions were also drawn by Butler, who is personally familiar with the facts derived from the North Islands, in an article which appeared in the *Zoologist* for 1864. The fresh discovery therefore of well-preserved remains of the Moa only tends to confirm and establish these views; and it would have been unnecessary to enlarge on the subject by the publication of the foregoing notes, which for the most part were written several years ago, but for the entirely opposite conclusions advanced by Dr. Haast in a recent address, which, from the large amount of interesting and novel matter it contains, will doubtless have a wide circulation.

JAMES HECTOR

ON THE GASEOUS AND LIQUID STATES OF MATTER

A DISCOURSE was delivered on Friday evening, June 2, at the Royal Institution in Albemarle Street, by Dr. Andrews on the "Gaseous and Liquid States of Matter," from which we make the following extracts:—"The liquid state of matter forms a link between the solid and gaseous states. This link is, however, often suppressed, and the solid passes directly into the gaseous or vaporous form. In the intense cold of an arctic winter, hard ice will gradually change into transparent vapour without previously assuming the form of water. Carbonic acid snow passes rapidly into gas when exposed to the air, and can with difficulty be liquefied in open tubes. Its boiling point, as Faraday has